The following donations were then presented:—

A collection of sixteen Original Views of the principal Buildings in Dublin, by the late George Petrie, LL. D.: presented by the Marquis of Kildare.

A perfect and beautifully formed Celt, of micaceous grit, found in a bog near Hacketstown, county of Carlow: presented by the Hon. and Ven. Archdeacon Stopford.

The Secretary read a letter from C. Darwin, Esq., returning thanks for his election as Honorary Member of the Academy.

MONDAY, MAY 14, 1866.

Sir William R. W. Wilde, M. D., Vice-President, in the Chair.

John Barrington, Esq., D. L.; John Casey, Esq.; and William Frazer, Esq., were elected Members of the Royal Irish Academy.

The Rev. J. H. Jellett read a paper

On a Fluid possessing Opposite Rotatory Powers for Rays at Opposite Ends of the Spectrum.

He commenced by alluding to the construction of an instrument which he had exhibited and described to the Academy some time ago.* The purpose of this instrument is to measure the rotatory power of a transparent fluid, not directly, but by the method of *compensation*. For this purpose the ray of polarized light, before† its passage through the fluid under examination, is transmitted through a fluid of an opposite rotatory power; and the construction of the instrument provides a method of varying and measuring with exactness the length of the column of this latter fluid through which the ray passes. The fluids used for this purpose were, in general, the two well-known species of oil of turpentine—namely, that which is obtained from the *Pinus maritima* of the South of France, and that which is obtained from the *Pinus Australis* of North Carolina. The former of these, being a left-handed substance, is used in the examination of fluids which, like the solution of cane sugar, are right-handed; and the latter, being right-handed, for those substances which, like the solution of quinine, and the great majority of fluids possessing the rotatory power,‡ are left-handed.

A means is thus obtained of comparing the rotatory powers of all fluids for which the rotation is in the same direction; but, in order to compare those whose rotatory powers are opposite, it became necessary, in the first place, to ascertain the relative rotatory powers of the

* "Proceedings," vol. viii., p. 279.

† The order of transmission is indifferent, but the construction of the instrument requires that the light should pass *first* through the compensating fluid.

‡ So far at least as the author has examined them.

two standard fluids. This was, of course, to be done by compensating with one of these fluids the effect produced by the other. When this is done, it is plain that the length of the columns of the two fluids through which the light passes will be inversely proportional to their rotatory powers. The author did not anticipate any difficulty in effecting this compensation; for, inasmuch as the two species of oil of turpentine, chemically identical in their composition, differ very slightly in their refractive and dispersive powers, the law assumed by Biot would lead us to expect that the rotations produced in the planes of polarization of any two homogeneous rays should be in nearly the same ratio in each of these fluids. If this were true, the ratio of the lengths of equivalent columns of these fluids should be nearly the same for all the rays of which white light is composed; and therefore, when these columns are so proportioned that the *intensities* of the light in the two images* are the same, the *tints* will also be the same, so that there should be no difficulty in making the experiment.

The actual result, however, was wholly different from that which the law of Biot had thus led the author to anticipate. So far from giving a tolerably perfect compensation, the two species of oil of turpentine compensate each other more *im*perfectly than any two substances which the author has examined—in fact, it is scarcely possible to make the experiment at all. When the lengths of the columns of fluid are so adjusted that the intensity of the light shall be the same in the two images,† the tints are found to be wholly different. The left-hand image shows a very brilliant sky-blue, and the right-hand image an equally brilliant rose colour; the beauty of these colours is very remarkable. There is, therefore, plainly a deficiency of red light in the left-hand image, and a deficiency of blue light in the right-hand image.

In seeking to interpret this appearance, it is to be remarked that when the light passes through a single fluid whose rotatory power is not very great, left-handed rotation is indicated by the darkening of the left-hand image, and right-handed rotation by a similar effect produced in the right-hand image. Assuming, then, that, in the compound effect produced by transmission through the two columns, the rotation is compensated, or in other words reduced to zero for the mean ray, it is plain that this effect will be left-handed rotation for the red ray, and right-handed rotation for the ray at the other extremity of the spectrum. It is evident, therefore, that the right-handed or Carolina turpentine rotates the plane of polarization of the red ray *less*, and that of the blue ray more than the left-handed or Bourdeaux turpentine. The Carolina

* "Proceedings," vol. vii., p. 349.

† So far at least as this can be effected; but the truth is, that it is almost impossible to compare with any tolerable degree of accuracy the intensities of light whose colours are so different. Even readings taken by the same observer will not agree with each other, and the *personal equation* will obviously be very large.

turpentine is, therefore, more *dispersive* of the planes of polarization than the other.

In reasoning on this experiment it occurred to the author that a similar effect ought to be produced if the ray of polarized light, instead of passing successively through two columns of French and American oil of turpentine, were transmitted through a single column, composed of a mixture of these two fluids. As they are identical in chemical composition, it did not seem probable that any chemical action could take place; and therefore, in accordance with the principle found to hold good for mixtures in general, the effect of two columns of fluid, when mixed together, ought to be the sum of the effects which they produce separately. If, therefore, the lengths of the two columns be such that they compensate each other for the mean ray, the fluid produced by mixing them together ought to exercise a left-handed rotation on the plane of polarization of the red ray, and an opposite effect upon that of the blue ray.

This anticipation was fully realized by the actual experiment. Some difficulty was found in ascertaining experimentally the exact proportion in which the fluids should be mixed together. The source of this difficulty is, as has been before stated, the impossibility of comparing with exactness the intensities of lights whose colours are different, and therefore of ascertaining the ratio of the lengths of two columns which compensate each other for the mean ray; and a small deviation from the true proportion will render the rotation produced by the mixture either wholly right-handed, or wholly left-handed.

The best method of ascertaining this proportion is to measure successively the actual rotations produced by each kind of oil of turpentine in the planes of polarization of the red and blue rays. Let F_r be the rotation produced in the plane of polarization of the red ray by the column of Bourdeaux turpentine; F_b that produced in the plane of polarization of the blue ray, and A_r, A_b, the corresponding rotations produced by American turpentine; then, if m be the quantity of French turpentine in the mixture, and n the quantity of American turpentine, the mixture will be right-handed for the red ray (and therefore *à fortiori* for all the rest), if

$$\frac{n}{m} = \text{or} > \frac{F_r}{A_r};$$

on the other hand the mixture will be left-handed for the blue ray, and therefore for all the less refrangible rays, if

$$\frac{n}{m} = \text{or} < \frac{F_b}{A_b};$$

and if the value of $\frac{n}{m}$ be intermediate to these two values, the fluid is possessed of double rotation. The phenomenon is rendered most striking by giving to the two fluids in the mixture such a proportion that the left-

handed and right-handed rotations may be equal to each other. If this be so, we shall have

$$mF_r - nA_r = nA_b - mF_b;$$

whence

$$\frac{m}{n} = \frac{A_b + A_r}{F_b + F_r}.$$

In order to measure exactly the quantities A_r, A_b, F_b, F_b, it was necessary in the first place to obtain rays as nearly homogeneous as possible. This was easily effected in the case of the red ray by transmitting a solar beam successively through blue and red glasses—this combination, as is well known, only permitting the extreme red ray to pass. It is not possible to obtain so homogeneous a ray at the other extremity of the spectrum; but the condition is very approximately fulfilled by transmitting the ray through a solution of sulphate of copper supersaturated with ammonia. The light transmitted by a sufficient thickness of this fluid, though not homogeneous, is almost entirely composed of rays situated at the violet end of the spectrum, the red, orange, and yellow rays being nearly extinguished.

The following were the values obtained for a column of each fluid whose length was four inches:—

$$A_r = 6^\circ\ 58',$$
$$A_b = 33^\circ\ 36',$$
$$F_r = 19^\circ\ 45',$$
$$F_b = 61^\circ\ 23',$$

Hence we find

$$\frac{m}{n} = \cdot 499.$$

When a mixture made nearly in this proportion was traversed successively by solar light which had passed through a combination of red and blue glass, and by light which had passed through a sufficient thickness of the ammoniacal solution of sulphate of copper, the effect was very striking. With blue light, the *left* side of the spectrum was almost quite black, while the right side was a bright violet-blue; with red light, the *right* side of the spectrum is nearly black, and the left side a bright red. This appearance indicates that the fluid, through which the light has been transmitted, is left-handed for the red ray, and right-handed for the blue and violet. The actual rotations are—

For red light, ... $-\ 1^\circ\ 45'$,
For blue light, ... $+\ 1^\circ\ 56'$;

the mixture containing 67 parts of American turpentine, and 33 of French turpentine. The ratio in which the two species of oil of tur-

pentine should be mixed, in order to produce this phenomenon, must be understood to apply only to the particular specimens examined; for the rotatory power of oil of turpentine will be found to vary with the specimen used, and also to some extent with the number of distillations to which it has been subjected. To insure success, this ratio must be determined by actual measurement for the specimens of oil of turpentine examined. A certain amount of difficulty attends this measurement, arising from the impossibility of obtaining a homogeneous blue or violet ray of sufficient intensity for the purpose of the experiment. Even when transmitted through a strong solution of sulphate of copper supersaturated with ammonia, the beam will still contain a considerable mixture of rays of different refrangibilities. The rotations A_b, F_b, cannot therefore be measured with perfect accuracy. It is possible, also, that, if the specimens of turpentine be not very pure, there may be some chemical action between the two fluids which will cause the rotation to vary. There may thus be a certain amount of discrepancy between the observed and calculated results in the case of the mixture. Thus in the present case the calculated rotations are—

For red light, ... $-1^\circ\ 51'$,
For blue light, ... $+2^\circ\ 6'$.

Sir W. R. W. WILDE read the following unpublished Letter, written by Lord Meath, July 14, 1690, respecting the Battle of the Boyne, and addressed to an ancestor of Sir George Hodson, Bart., of Hollybrook, Bray, who had kindly permitted him to submit it to the Academy:—

"*Dublin, Thos Court, July ye 5th* (90).

"MADAM,

"Yesterday morning I entered this Tonne; after our army & King James had a smart battle for 4 or 5 houers on this side ye Boyne boath our whole armies being verey warmly engaged; it happened ye first of July about 11: in ye morning where King William forced ye passe on ye river Boyne called Old bridge 3 miles from Droheda (in person) under ye enemys Great gonnes mercey and ours; with small shott Like showers of Leden hale stones; King William yewing ye enemys Campe ye day before ye engagement was shott with an 8 pounder which tooke of his coat of his shoulders, and just drew blood from his skinn; he called for a napkin and an other coat; and after yt was settled upon him he stretched out his arme 3 times and sayd without ye least passhion; The enemy designed to prevent his fighting next day; But sertanly I ll be to-morrow amongst ye thickest of them. He was just to his word; for ye next day he fought through ye passe and with losse on boath sides he tooke ye Battery of ye enemyes great gonnes and killed all ye small shott men yt endeavored to (?) it; soone after he charged ye enemy in ye Reare broke there first lines, and our other line being in ye front of theres; wee drew up to Inclose ye enemy's whole army; but a damned (?) deepe bog being betweene we could not

soone passe it which gave y^{em} time to run for it and y^{e} night drawing neere wee did not persue till next morning ; and then it was too late ; but well enough ; for y^{e} fled to Dublin and made short stay there ; for King James, Terconnell Ec^{t} flew through the county of Wickloe in order as I suppose to take shipping at the y^{e} first port where they can find vessells to transport them ; we killed beside prisoners betweene 6 & 7 thousand, most of there best officers lay ded and gasping upon y^{e} ground ; wee lost Duke Shonberg killed in y^{e} neck with a muskett ball & somme few officers & soldiers inconsiderable for sutch an engagement ; the enemy is so disperced and threw away their armes & run westward y^{t} there is no danger of there ever Ralling againe, so y^{t} you may be pleased with the event of a few howers fighting which brings you all home to y^{r} safe interests & propertys, which I desier may bee for my owne sake as well as yours as soone as you can ; my servise to y^{e} family of Hobs & Nobs ; and y^{e} Salley stakes are once againe freely at y^{r} servise, who am,

"Madam

"Y^{re} one hum^{ble} Servant

"Meath.

"Pray let Matt Anderson & all our friends partake of this thuth we tooke Lieut^{t} Gen^{ll} Hamilton prisoner who I believe will soone be executed. I am sent for to y^{e} Campe neere Glasscneivn and can add no more particulars att present."

The thanks of the Academy were returned to Sir George Hodson, Bart., for his permission to exhibit and publish the abovementioned letter.

J. Kells Ingram, LL. D., read a paper, by the Rev. James Byrne, "On the Science of Language."

The Secretary of the Academy informed the meeting that Sir Richard O'Donnell, Bart., was in waiting, and desired that the Caah of Columbkille should be now delivered to him on his personal demand.

It was moved, seconded, and—

Resolved,—That Sir Richard O'Donnell be requested to present himself.

Sir Richard O'Donnell then entered the meeting, and signified his wish that the Caah should be forthwith returned to him, agreeably to the conditions upon which he had deposited this reliquary, and its custody had been accepted by the Academy.

The Caah was thereupon produced, and returned by the Chairman into the hands of Sir Richard O'Donnell.

It was then moved, seconded, and—

Resolved,—That the hearty thanks of the Academy are due, and are hereby offered to Sir Richard O'Donnell, Bart., for his kindness and consideration in having for so many years allowed this venerable and historic reliquary to remain in their Museum.